



Contamination Experiment



Midcourse Space Experiments (MSX) Contamination Results

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**Contamination Effects on Optical Measurements, Characterization
of S/C Environment and Validation of S/C Contamination Control.**



Contamination Experiment



Outline

- **MSX Mission and Contamination Objectives**
- **Contamination Approach**
- **Contamination Instruments**
- **Early Operations Flight Results**
- **Cryogen Phase Results**
- **Post Cryogen Phase Results**
- **Summary**
- **Other Scientific Results of Interest**



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Members of the CEPI Team:

- **Science Investigators:**
 - Dave Green and Gary Galica from PSI
 - Dick Benson, Dave Silver, Bob Erlandson, Mark Boies and Manny Uy from JHU/APL
 - Bob Wood from AEDC
 - Dave Hall from Aerospace Corporation
 - Jim Dyer from USU/SDL
- **Data Analysis Center Engineering Team:**
 - Jeff Lesho and Russ Cain from JHU/APL
 - Phil Mulhall from PSI
- **Operations Coordinator:**
 - Ric Reinders from JHU/APL
- **Technical Collaborators:**
 - Ed Murad from PL/GL
 - Gerry Keating and Bob Tolson from George Washington Univ./Langley.
 - Philip Chen, Joe Grebowsky and Wayne Kasprzak, from GSFC



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INSTRUMENT

Neutral Mass Spect.

Ion Mass Spect.

Total Gas
Pressure Sensor

Quartz Crystal Micro-
balance

Krypton / Radiometer

Xenon Flash Lamp

CONTAMINANTS

H₂O, H₂, O, hydrocarbons

H⁺, O⁺, OH⁺, CH₄⁺

1E-5 to 1E-10 Torr

Surface Contaminants
($\leq 1.5\text{E-}9$ g/cm²/Hz TQCM)
($\leq 4.2\text{E-}9$ g/cm²/Hz CQCM)

Near field H₂O,
O + H₂ / H₂O reactions
Min [H₂O] = $3\text{E}6$ / cm³

Particulates
(ice, alumina, paint)
Min size : 0.5 micron

TYPE

Quadrupole
1 To 150 AMU.

Bennett RF
1 to 56 AMU

Inverted Cold
Cathode Gage.

Peltier Cooled
QCM (4)
Cryogen Cooled
QCM (1)

VUV Photodiss.
OH Fluorescence

MIE Scattering
w/ WFOV Imager



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OBJECTIVES

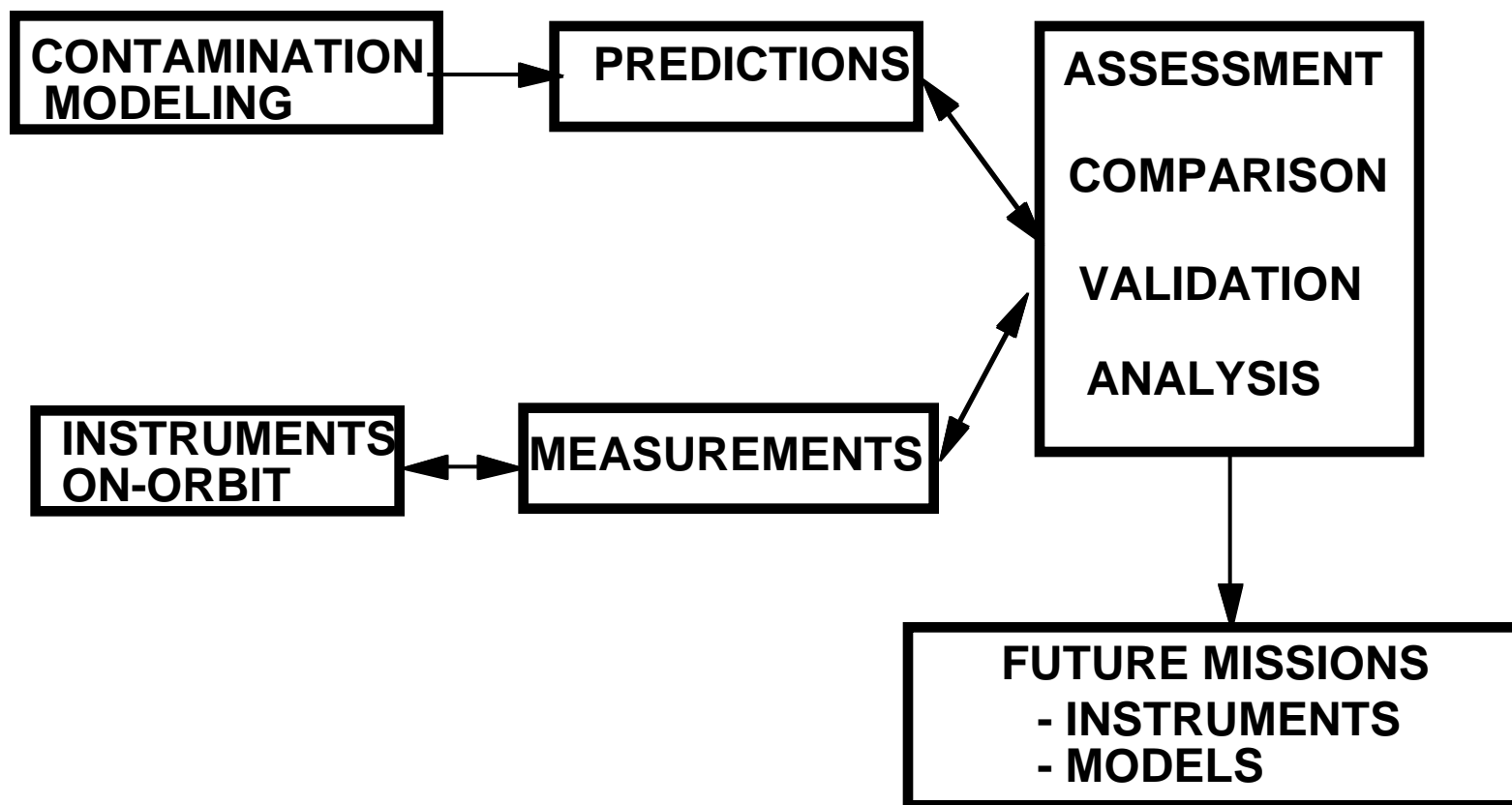
1. Study the effects of molecular and particulate contamination on the MSX sensors, e.g. on the nonrejected earth radiance (NRER) of Spirit III, UVISI and SBV and to transfer these result to the next system element.
2. Provide contamination status during the MSX mission, including resolution of anomalies.
3. Develop a validated contamination effects model for the next system element.
4. Assess the effectiveness of the ground contamination control plan for future programs.



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EXPERIMENTAL APPROACH





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Early Operations (Apr. 24 - May 1, 1996)



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TPS

- Measurements agree with model for rapid equilibration effect of blankets and $t^{-1.0}$ decay.
- Measured argon pressures in close agreement with predictions.
- Indicated S/C events, e.g. SPIRIT III argon pressure variations as confirmed by door temperatures.
- Measured orbital effects of argon at 1x and 2x orbital period
 - confirmed by NMS data
- Measured rotational and linear velocity of SPIRIT III cover after release
 - period = 4.9 sec
 - velocity = 15 cm/sec.



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NMS

- NMS argon temporal behavior similar to TPS results, i.e. $t^{-1.0}$ decay.
- Water vapor temporal behavior similar to KR, $t^{-1.0}$ at MET<45 h and , $t^{-0.8}$ at MET>45 h.
- Organic species ($m/z>46$) below detection limit of 2×10^5 /cc at turn-on
 - Detected $m/z=69$ (possible CF_3 fragment ion) during Solar Bakeout Experiment.
- Measured inorganic species at $m/z=19, 23, 35, 37, 39$ and 40 after NMS door deployed but not before, indicating F, Na, Cl, K and Ca (or MgO).
 - Possible inorganic debris from ceramic during NMS cover opening.

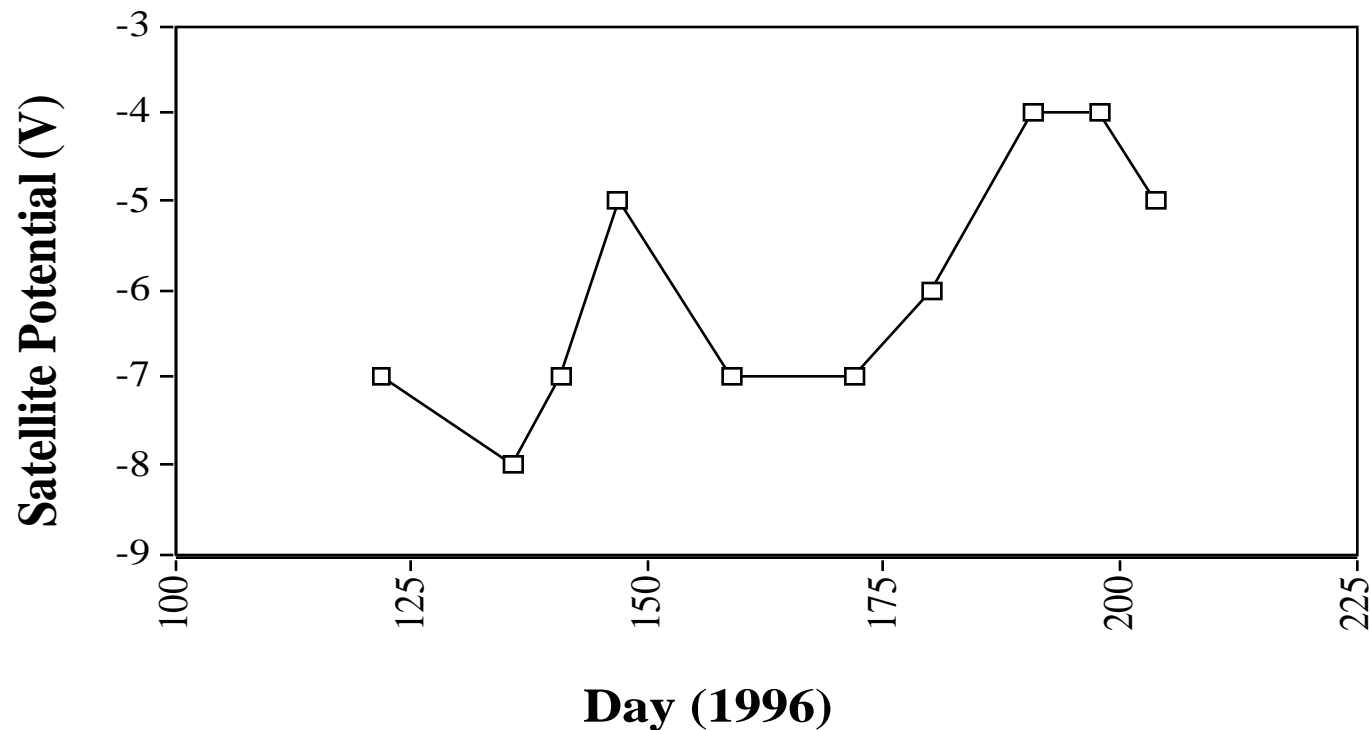


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MSX Satellite Potential

MSX CE IMS Summary Plot





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IMS

- Observed ionospheric ions H^+ , He^+ , N^+ and O^+ .
- Observed H_2O^+ due to charge exchange reactions between $O^+ + H_2O = H_2O^+ + O$.
- Calculated spacecraft floating potential with observed “I-V curve” for H^+ and O^+ .
 - Spacecraft potential between -5 to -10 volts.



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Early Operations Results (April 24 - May 1, 1997)

- Molecular Species from TPS, NMS and KRE
 - SPIRIT III door venting and ejection
 - Initial gas composition and organic molecules
 - Water vapor densities vs prediction
 - Gas composition after SPIRIT III door ejection
- Film deposition on QCM's
 - SPIRIT III door ejection affected CQCM and TQCM's
 - Thicknesses measured not a concern for SPIRIT III
- Particles measured during cover ejections and terminator crossings.
- S/C charging measured



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Cryogen Phase (May 1996- Feb. 1997)



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Post Cryogen Phase (March 97 - ?)



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Summary:

- **MSX Contamination Control Plan successful in launching a clean spacecraft, e.g. negligible hydrocarbon contamination and rapid decay of water vapor**
- **Contamination model and contamination instruments successful in performing rapid evaluation of risk to optical sensors during early operations**
- **MSX contamination model for quiescent spacecraft has been validated**
 - **Future models need to account for spacecraft dynamics, especially solar effects**
- **MSX contamination instruments will continue to monitor outgassing, film deposition, and particulate generation for duration of program.**